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golden, yet queer little eyes, chameleon-like, independent of each other, intently gaze two ways at once. Then as to that dorsal fin, in oddity and beauty it has no compeer among its ichthyic rivals, so tastily fringed with a neat border of delicate yellow, precisely like the yellow tipping of the tail of the Cedar-bird (*Ampelis cedrorum*). In truth, this dorsal fin is cruelly libelled in every engraving we have ever seen. In nature it is an exquisite fan, in form, size, and ornament, worthy the hand of Queen Mab. Thus our Sea-horse, though anomalous in form and habit, has beauty united with its strange features, and grace with its eccentricity. In fine, as we look at his equine appearance, and think of his monkey faculty, and his opossum traits, and that queer blending of innocent oddity with patriarchal dignity, we have to accept the old fisherman's proverb,—"There is nothing on the Land that is not in the Sea."

THE RECENT BIRD TRACKS OF THE BASIN OF MINAS.

BY C. FRED. HARTT, A. M.

(Concluded from p. 176.)

Sir Charles Lyell, who visited Nova Scotia in 1842, first called attention to the recent bird tracks of the Basin of Minas, and Dr. J. W. Dawson, the distinguished Nova Scotian geologist has treated of them in his interesting little volume, "Acadian Geology."

The mud flats of the Minas Basin are made up to a very large extent, some entirely, of these thin layers of mud, deposited by the successive tides. The deposition of the layers does not of course go on equally everywhere, but only in localities sheltered from the action of too strong currents. In these accumulations there is thrown down a layer for each tide, those deposited by the night tides being thicker than those formed during the day. During a long interval of repose thin layers only are deposited, while just after a heavy storm that stirs up the whole bay, the deposits are much increased in thickness. Nor are these accumulations confined to the shoals laid bare at low tide; but they extend over the bottom of the Basin, though they must naturally be much thicker near the shores whence the materials were originally derived. Dr. Dawson says that "these layers are thicker on the edge of the flats than near the shore; and hence these flats, as well as the marshes, are usually higher near the channels, than at the inner edge. From the same cause, the more rapid deposition of the coarse sediment, the lower side of the layer is arenaceous, and sometimes dotted with films of mica, while the upper side is fine and shining, and when dry has a shining and polished surface. The falling tide has little effect on their deposits, and hence the growth of these flats, until they reach such a height that they can be overflowed only by the highest tides."

It is to the zone embraced between high and low-water marks that the subaerial tracks, such as we have described, are confined, the only markings made on the submerged layers being entirely those of aquatic animals, tracks of crabs and other crustaceans, trails of shell-fish and marine worms, or scratches made by fishes; but markings of this kind may extend over the whole part reached by the tide, while low tide is the lowest limit at which tracks of land animals can be found.

The *Tringæ* and other waders visit the shores of the Basin only in the summer, so that through the whole series of layers formed during the winter, none of these tracks occur. In the winter months the shores are encumbered with masses of ice and snow, and are quite deserted. The floating ice scores and ploughs up the banks in exposed localities, and the regularity of the deposits must be very much broken during that time. The ice forming on the shores and floated off at high tide carries away an immense amount of shingle and loose material, often large boulders, and drops them over the bottom of the whole Basin, and one sees blocks of trap from Blomidon lying on the flats about Horton and Cornwallis. This annual drift phenomena must leave its record in the boulders and coarse material distributed through the finer material laid down during the winter, while the summer layers would be entirely free from them.

It will be readily seen that the mud deposits can only accumulate in the quieter parts of the bay, and that as we go from these to points where the tidal currents increase in velocity, we shall pass from mud deposits to those of sand and gravel, while the shores will vary in the character of their beaches according to the kind of rock exposed at the water's edge. Thus under the red sandstone cliffs of Cornwallis and Blomidon, we have sand beaches in exposed localities, muddy shores where the waves are shut out, while trap-shingle is strewn along the shores of Blomidon.

The Strait of Minas is very narrow, and one can readily imagine that the immense mass of water which twice a day is poured into the Basin, and twice a day drained off again, must cause tremendous currents setting through the strait, and that wherever these are felt, only the coarser deposits are to be looked for.

These mud banks, these accumulations of sand, gravel, and shingle really form a great diary of the life of the Basin, and we see that the history that is daily written upon them is readily to be translated. Well, we have got our boots and pants well covered with mud, we have gathered a handful of specimens of bird tracks and a pocket full of muddy shells, and we have learned something of how Nature writes down in her great Stone Book the history of the world. Before us are the last few pages of the manuscript, and we have watched in the tracks left by the running bird, the pen gliding over the page. Aye, we too have added our lines to the history. Will the coming tide respect them and seal them up forever, or will it blot them out as unworthy of a place on the page? Behind us and around us in the hills are volumes written long ago by the same ever-recording pen; but Nature makes *palimpsests*, as did the scribes of the middle ages, and writes over and over on the same page. See, yonder at the mouth of the Avon is a range of cliffs called Horton Bluff, formed of layers of the lower coal measures. They form a chapter in the geological history of the Province, and are written all over with quaint old records of ancient forests of coal-plants, and of antique mailed and spine-armed ganoid fish; but the scribe, wanting material on which to record the history of the present, is destroying the old manuscript, spreading out its leaves anew, re-prepared for the more modern characters in which the chapter of to-day is being written. After all our scribe is but a chronicler, like old Froissart. Geologists are the historians that work over this material. They are not satisfied with leaving the detached facts recorded, but ask the *why* and the *wherefore* of their occurrence and their relations one to another. One who merely translates the detached facts of the geological record is no more entitled to be called a geologist, than a translator of Froissart can claim to be a historian.

If you were to examine the beds of Horton Bluff, you would occasionally find one on whose surface are markings, such as we observe nowadays being made on the sea-shore; some of the layers are ripple marked evidently by the waves, or by shallow agitated water. All these beds were deposited under water in the shape of sand and mud. The late Dr. Theodore Harding, of Windsor, discovered on the surface of one of these layers, the tracks of a kind of reptile. The animal had evidently walked about over the rock when it was soft, and its footprints were preserved just as the recent impressions of birds' feet are now being preserved on the shores near the bluffs. Tracks of worms are sometimes found on the same beds, and at Parrsboro' we have found what appear to be the tracks of some large crustacean.

Tracks of animals have been formed, of course, ever since the world has been inhabited, and these are preserved in rocks of all ages wherever the necessary conditions obtained, from the Lower Silurian "Lingula flags"* of St. John, New Brunswick, to the deposits now forming.

Many years ago, Dr. Deane found on the surface of slabs of sandstone, quarried in the Connecticut valley, the tracks of a three-toed animal which he took to be a turkey; but Professor Hitchcock, of Amherst, having examined them, showed that they were not made by that fowl, but by some bird-like animal long since extinct. Attention being called to the subject, it was found that these and other footprints were scattered through a great thickness of these sandstone beds, and Professor Hitchcock, before he died, described over one hundred species of animals from their tracks found in the Connecticut River sandstone. There cannot be the slightest doubt that during the Triassic period the valley of the Connecticut, from New Haven to a point about one hundred and twenty miles north of that city, and with an average width of about twenty miles, formed an estuary, to which the sea had imperfect access, and that the sandstones and shales which now fill it, were therein deposited, under circumstances exceedingly like those under which the mud deposits are now accumulating in the northern estuaries of the Avon and Cornwallis, though there was there a slow submergence going on which gave an opportunity for the distribution of the tracks through hundreds of feet of beds, a thing which would otherwise have been impossible. In this estuary were extensive mud-flats and sand-banks covered by high tide, and left bare when the tide was out, and these were the resort of great numbers of animals whose footprints are alone preserved. The majority of these animals were reptiles, but others were probably birds. Huge fellows were some of them, making tracks about two feet in length. Yet, though these footprints are very abundantly handed down to us, the rocks themselves hold scarcely a vestige of animal remains. Besides a few fish, a shell or two, and an insect, only a few broken bones have been discovered thus far, and these last enable us to form only a suspicion as to the character of the animals to which they belonged. It would be very unlikely that the remains of land animals, which only frequented the shores between the tides, should be found in the deposits there forming, and we have already remarked how rare it is to find a dead bird on the Horton shores.

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* The writer pointed out the primordial age of these beds in 1865. Mr. E. Billings believes them to be the exact equivalent of the "Lingula flags" of England.

Some of the shale-beds of the Connecticut valley resemble very closely, both in color, texture, and composition, the dried mud-layers of the Basin of Minas. I have before me now a slab from one of the finer-grained beds of the Connecticut valley. Except that it is more solid, it could not easily be distinguished from a well-baked specimen of the Minas mud. Its surface is marked with beautifully preserved rain-prints, as clearly impressed as one sees them after a mid-day "sprinkle" on the Horton mud-flats, and to make the resemblance more complete, there is on one side an incipient crack, like the gash of a knife where the mass in shrinking had begun to tear apart, but had not separated sufficiently to form a complete crack.

From these studies we must see that the phenomena going on around us must be the Rosetta stone, which shall furnish us with the key for the deciphering of the hieroglyphics of the Stone Book, and that we shall understand the results of the forces which acted in the past, in proportion as we correctly understand their action in the present.

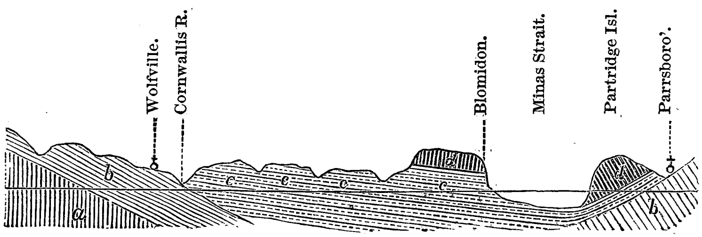
Let us now see what was going on "down east" when the Connecticut valley was an estuary. Nova Scotia had at that time very much the same appearance as at present, but the land was more sunken, and the range of hills that skirts the Bay of Fundy, the North Mountains, did not then exist. The bay washed the northern slope of the South Mountains, and the Basin of Minas formed the head of the bay. The shores of the Minas Strait were then on the north, very nearly as at present; but Capes d'Or and Sharpe, as well as Partridge Island, and the Two or Five Islands, now noted for their beautiful zeolitic minerals, had not yet a being; neither had Isle Haute lifted its lone head above the waters of the bay. On the south the shore ran along the range of hills, the continuation of the South Mountains, from Kentville by Wolfville, and the

Horton Mountains to Truro. There was then no strait at all. The Basin opened broadly into the Bay of Fundy. Cobequid Bay was much wider than at present, and penetrated eastward beyond Truro. One of the Acadian provinces, Prince Edward Island, was wanting.

Within the whole bay thick beds of red sand were deposited, and similar strata were at the same time accumulating in the Gulf of St. Lawrence, off the northern coast of Nova Scotia, and especially over the area now occupied by Prince Edward Island. These beds now form a coarse friable red sandstone which is almost entirely barren of fossils, for it had afforded only a few reptilian remains in Prince Edward Island. Acadia must at that time have been peopled with animals, and covered with vegetation; but the conditions for the preservation of the remains of either were very unfavorable. The bay was then open to the full sweep of the tide, which may at that time have acted with even much greater force in the region of the Basin of Minas than at present, because the tidal wave, not being obliged to pass, as at present, through the narrow Strait of Minas, would have had an opportunity of exercising its full force, rising higher and higher as it rushed up the ever-narrowing head of the bay, but it may have been that at that time the isthmus which unites the peninsula of Nova Scotia with the main land was submerged, in which case the extraordinary tidal phenomena of the Bay of Fundy could not have resulted. The sandstone beds show, in their oblique lamination, the action of strong and shifting currents. There was not the same opportunity presented for the preservation of such footprints as may have been left on these sands, as existed in the quiet estuary of the Connecticut, or the present Basin of Minas. At intervals during the deposit of the Connecticut River beds, there were volcanic disturbances, attended by the formation of dykes, and the spreading out over the beds of thick masses of lava. The New-Red Sandstone period was attended in Nova Scotia by similar phenomena. Just after the formation of the sandstone beds in the Basin of Minas and Bay of Fundy, submarine volcanic action broke out along the line of the present North Mountains, and immense quantities of melted matter were thrown up from beneath, and spread over the New-Red Sandstone strata, either in liquid, molten streams, or a volcanic ash. This ancient lava is called *trap*. The volcanic disturbance went on for some time, until these beds had acquired a great thickness. Similar eruptions took place at the same time at the Two, Five, and Partridge Islands, Capes d'Or and Sharpe, and at the Isle Haute. It is very probable that all these now isolated trap masses may have been at that time continuous.

The land was then elevated so as to bring all their beds in the Basin of Minas, and along the shores of the Bay of Fundy above water, and as the red sandstone beds had a slight dip to the northward along the southern coast, the volcanic beds had a like dip towards and under the bay. The trap beds were very thin inland, but became thicker towards the shore. Running water began its work on the southern edge of the trap deposit, along the present line of the valley between the North and South Mountains, and with the assistance of glacial action and the sea, which afterward flowed through it, excavated that depression. To the north, the waves, beating along the whole bay coast for centuries, cut away the trap-beds, so that we have now only a narrow strip left, the North Mountains from Blomidon to Briar Island. At the time of the elevation of the New-Red Sandstone beds, the Basin of

Minas, as well as a large portion of the Bay of Fundy, was occupied with them ; but they have since been largely removed, except where overlaid by trap deposits, or otherwise protected, and only small remnants are now left fringing the shores of Nova Scotia and New Brunswick. Prince Edward Island made its appearance with the rise of the land, and it must at first have been of much greater extent than at present, perhaps even having been united to Nova Scotia.



a, Silurian strata. *b*, Carboniferous sandstone and shales. *c, c, c, c, c,* Triassic red sandstone. *d*, Trap overlaying red sandstone.

The reptiles and birds of the New-Red Sandstone period have passed away, and the earth is peopled by a new creation. In that period the world had reached that stage in its development when it was fitted for the rule of the brute force of giant reptiles. To-day *mind* rules. God's other creations signed their mark on the pages of geological history.

NOTE.—The above diagram is an ideal vertical section across the country from Wolfville to Parrsboro', intended to show the relative position of the beds of rock of which it is composed. The hills south of Wolfville consist of beds of sandstone and shale, *b*, belonging to the lower part of the Carboniferous formation. These beds are inclined to the north, and they rest on the upturned edges of beds of slate, *a*, of Lower Silurian age. Carboniferous beds, *b*, appear at Parrsboro', but they are much newer than those near Wolfville. In the trough-shaped depression in these Carboniferous strata, the ancient Basin of Minas, lie the thick beds of the New-Red Sandstone, *e, e, e, e*, which, except where they are protected by the overlying masses of trap, *d, d*, at Blomidon and Partridge Island, are worn away into low hills, or cut through by the river or the water of the Strait. The horizontal line represents the sea-level. This section is based on one by Dr. Dawson, in his "Acadian Geology," with additions by the writer.